UNCLASSIFIED

AD 438417

DEFENSE DOCUMENTATION CENTER
FOR
SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA

UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

438417

CATALOGED BY DDC
AS AD No.

RADC-TDR-64-31
FINAL REPORT

TEXT REPORTING AND EDITING DEVICE

TECHNICAL DOCUMENTARY REPORT NO. RADC-TDR-64-31

April 1964

Information Processing Branch
Rome Air Development Center
Research and Technology Division
Air Force Systems Command
Griffiss Air Force Base, New York

DDC
TISIA

Project No. 4594, Task No. 459402

(Prepared under Contract No. AF30(602)-3088 by William R. Nugent,
Infor/onics Inc., 146 Main Street, P.O. Box 207, Maynard,
Massachusetts)

438417

DDC AVAILABILITY NOTICE

Qualified requesters may obtain copies from the Defense Documentation Center (TISIR), Cameron Station, Alexandria, Va., 22314.

Releasable to OTS.

LEGAL NOTICE

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related government procurement operation, the government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

DISPOSITION NOTICE

Do not return this copy. Retain or destroy.

Suggested Keywords: Input-Output Devices, Punched Tabe

ABSTRACT

An experimental model of an automated aid to editing of textual matter in machinable form has been designed and constructed. The principal purpose of this work is to demonstrate the usefulness and need for small scale, inexpensive editing devices. Off-line special editing devices can provide a high percentage of computer capability in editing for a low percentage of computer cost due to the comparatively lower requirement of complexity and speed.

PUBLICATION REVIEW

This report has been reviewed and is approved. For further technical information on this project, contact Stephen Stromick, Ext. 23228.

Approved: FRANK J. TOMAINI
Chief, Info Processing Branch
Intel and Info Processing Div

Approved: ROBERT J. QUINN, JR.
Colonel, USAF
Chief, Intel and Info Processing Div

FOR THE COMMANDER:
IRVING J. GABELMAN
Chief, Advanced Studies Group

AIR FORCE, Cato Show Prtg. Co. 4/29/64 - 175 -

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Part I: Functional Description and Operator's Manual

1. INTRODUCTION

The Text Reporting and Editing Device described herein is a small scale, high speed, tape processor developed as a means of speeding data into accurate machine form for computer entry, communications and reporting. Attached to a common tape-typewriter, the Text Reporting and Editing Device permits the creation and editing of text-tapes with a speed and facility previously obtainable only by on-line computer programs. The Text Reporting and Editing Device has applications in the preparation and editing of data for intelligence, documentation, retrieval files, computer programs, library records, and publishing.

The Text Reporting and Editing Device permits an operator to issue rapid sequences of instructions via push-button, consisting of editorial functions operating on a selected number of natural text segments. The principal editorial functions are four in number:

1. Copy
2. Delete
3. Insert
4. Justify

There are six natural text segments that may be operated on and up to 30 of these may be specified in one keyboard command. These segments are:

1. Characters
2. Words
3. Lines
4. Sentences
5. Paragraphs
6. Records

By means of pushbuttons corresponding to these functions and segments, an operator may rapidly produce edited tapes at rates up to 50 characters per second. During the typing of text, the device provides a two character memory, display, and simplified error correction features that permit operators to use their maximum keying speed with confidence.

The detailed operations are discussed in Section 3 of this report, and a paper included as an appendix to this part of the report describes problems of editing machine media and compares the techniques of using on-line computers and the Text Reporting and Editing Device. In brief, we have found that this device can perform practically all editing functions possible on a computer, at comparable speed, and at a cost which is smaller by an order of magnitude or more.

2. CONFIGURATION

The Text Reporting and Editing Device, hereinafter called TRED, is shown in Figure 1. It consists of an equipment cabinet and an operator's pushbutton console. Both of these are cable connected to a tape-typewriter. The tape typewriter shown is a Friden Flexowriter with tape reader, tape punch, a 20 inch carriage, and an excess-three code structure. Any of a wide class of tape-typewriters may be used; any code structure may be used; and the attached tape-typewriter is not required to have its own reader or punch as these are not used with the TRED. The TRED contains a high speed reader and punch, which are used exclusively. A Tally reader is used and is visible in Figure 1 near the top of the equipment cabinet. A Teletype punch and a tape spooler are mounted on ball-bearing slides behind the front door. The punch is shown extended in Figure 2. During operation the door is normally kept shut to minimize noise. Access to the logic components, power supplies, fan, and rarely-used function switches is via the rear door. During use of the TRED, the operator need not be concerned with the equipment cabinet, as all control is via the Editor's Console. The tape-typewriter is used for print-out and data-entry only.

3. OPERATION

Editing text on the TRED is much like operating a small keyboard calculator; successive editing functions are directed via a pushbutton console, and these are executed almost as fast as they can be set up. We first describe the initial "Power-On" steps, and then describe the console controls.

3.1 INITIAL "POWER-ON" CONTROLS

3.1.1 <u>Tape-Typewriter On</u>

Operation begins by turning the tape-typewriter power <u>on</u> and making sure that the tape-typewriter's reader and punch are <u>not on</u>. The tape-typewriter is normally left cable-connected to the TRED, but when TRED power is off, the tape-typewriter may be used normally. When TRED power is on, it automatically switches control away from the tape-typewriter's reader and punch, but both must also be off.

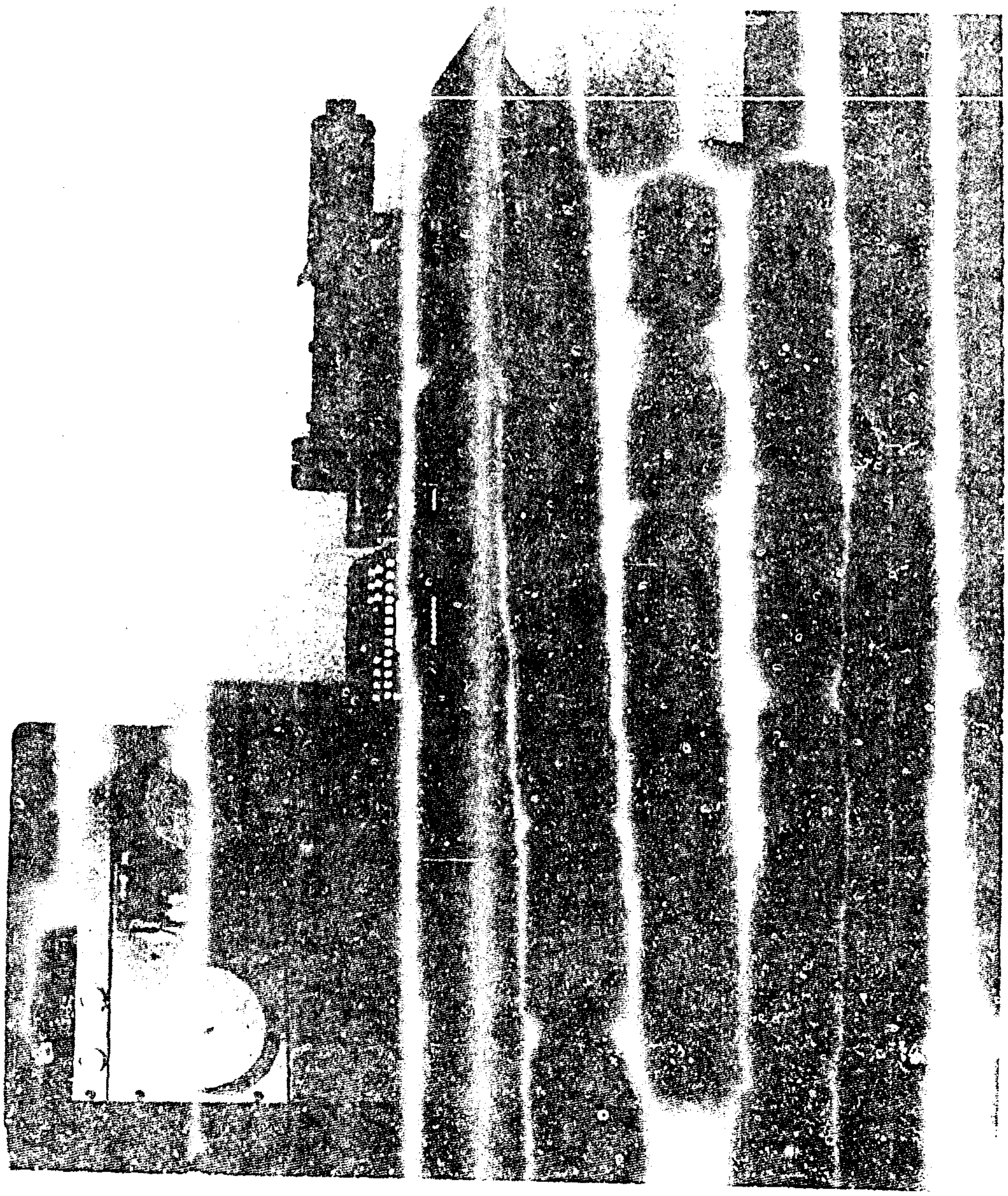

Figure 1. Text Reporting and Editing Device.

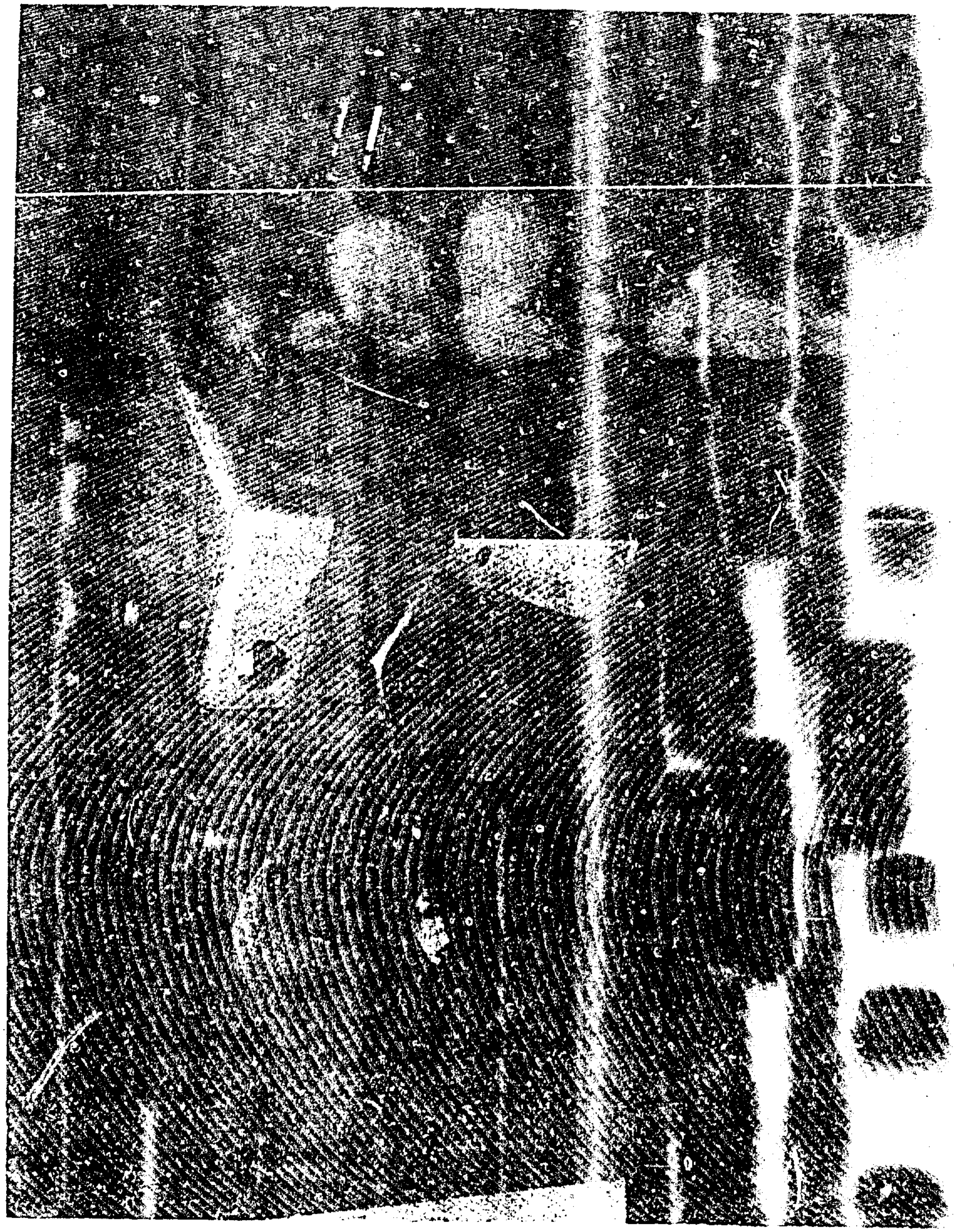

Figure 2. Teletype Punch Extended on Slides

3.1.2 TRED Power On

The left hand pushbutton light on the top of the equipment cabinet turns TRED power on and is activated next.

3.1.3 TRED Reader-Punch On

The right hand pushbutton light on the top of the equipment cabinet turns the TRED reader and punch on, and after activation of this switch, the operator will normally load the data tape into the reader. At this time, the operator may wish to check the punch to see if sufficient tape remains for the present processing.

3.2 CONSOLE CONTROLS

Once a particular tape-typewriter is attached to the TRED, practically all operation is via the operator's console shown in Figure 3. Familiarity with this console and the function of the different buttons is the prime requirement for an operator. The general operating sequence may be described very directly: An operator first selects an editorial function by one of the buttons COPY, DELETE, INSERT, or JUSTIFY; then selects the text segments to be operated on: CHARACTER, WORD, LINE, SENTENCE, PARAGRAPH, or RECORD; then selects a number button from 1 to 30 representing the number of text segments to be processed at once; and then depresses the START button which causes the instruction to be executed. We describe following the precise nature of the console controls and their functions.

3.2.1 COPY

In the COPY mode, we approve portions of the original text, which are correct, and direct that these portions be recopied exactly in the output tape. The machine will read input tape and will copy a selected number of chosen text segments (including their terminating delimiters as described in Section 3.2.5) at a rate of 50 characters per second when tape only is desired (HIGH SPEED mode selected), or at tape-typewriter speed (8 - 10 characters per second) when simultaneous page copy and tape are desired.

3.2.2 DELETE

Deletion is the removal of the unwanted or incorrect material from an original body of text. In the DELETE mode, the machine will read input tape and skip over a desired number of chosen text segments (including their terminating delimiters) at a rate of 50 characters per second. Since no page copy is ever produced, DELETE has no low speed mode.

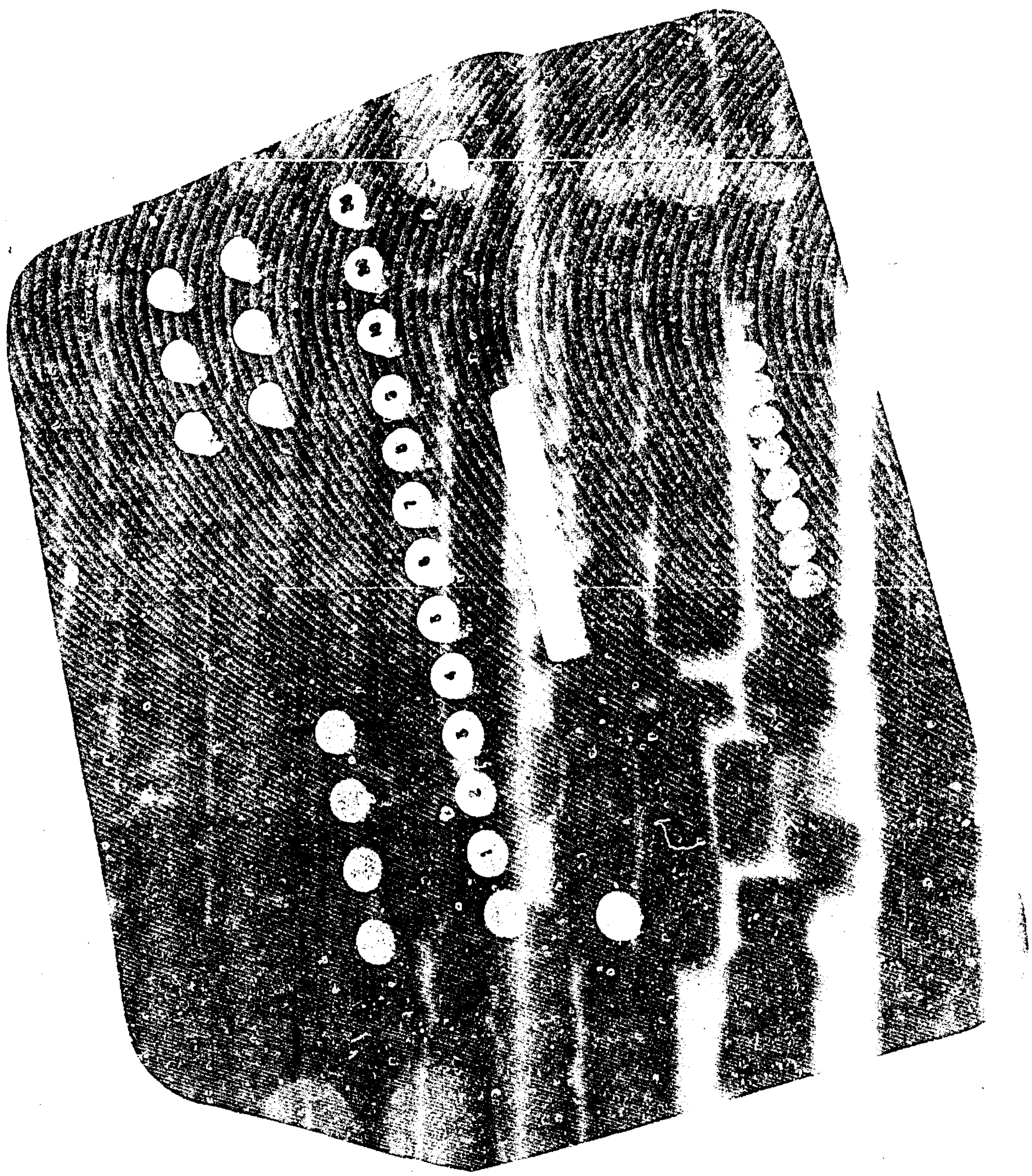

Figure 3. Operator's Console.

3.2.3 INSERT

Insertion is the addition of material between existing elements of original text. In the INSERT mode, the operator enters data via the keyboard in a normal way, and tape is punched on the device's punch. A two character buffer memory is provided between input and output so that typing errors of one or two characters may be corrected prior to punching, when the operator is aware that an error has been made. Since single miss-strokes and two character transpositions are the most frequent typing errors, the production of clean tape is greatly facilitated by TRED's two character memory. If a single error is made, the operator merely hits the "backspace" key and strikes over the incorrect character. The backspace signals the machine that an error has been made, so the corrected character is substituted in the output. To correct a two-character error, the operator depresses the CLEAR button which erases all machine memory.

In the INSERT mode, no text segments or numbers of text segments are specified, and the operator may type an indefinite amount of text. When the operator has typed the last character to be entered, the last two characters typed remain in storage, and it is necessary to perform a "finish" operation prior to changing modes. This may be performed by any two keystrokes, but the sequence "space backspace" is preferred since it causes no extraneous matter to appear on page copy.

3.2.4 JUSTIFY

Rejustification is the realignment of the right hand margins of text after an editorial change has resulted in a change in the length of a line and has caused subsequent lines to have incorrect format. In the JUSTIFY mode, the operator sets a right hand margin indicator several characters prior to the preferred end point of the text. The device then reads an input tape and fills a line with data up to that point. Carriage returns in the data are converted to spaces if they occur in the internal part of a line. Carriage returns after words are converted to single spaces, and carriage returns after sentences are converted to double spaces. When the line reaches the right hand indicator, automatic output ceases, and the

machine waits for line-end information to be typed in. The operator then types the last few characters of the line, hyphenating if necessary, and upon striking the carriage return, the machine resumes automatic output until the right hand indicator of the next line is reached. If, for instance, the machine has typed the first part of the word "information", say "info", and stopped at the right hand indicator, the operator may type either "r-↲" or "rma-↲" or "mation↲", and when the carriage return (↲) is typed, the machine will continue on the next line at the proper point.

When hyphens are encountered in the middle of a line during rejustification, the machine normally drops the hyphen and pauses. These hyphens will usually be old line break hyphens that are no longer desired in text. When this is the case, the operator merely depresses the PAUSE-RESUME button, and automatic operation continues. If the machine should pause at a permanent hyphen, the operator should switch to the INSERT mode, enter the hyphen, type the remainder of the line including carriage return, and switch back to JUSTIFY.

In the JUSTIFY mode, it is assumed that all data is correct and requires only reformatting. The operator should be sure that the two tab-switches are properly set when entering the JUSTIFY mode: The left hand tab-switch should be at the left hand margin, or slightly to the right of it, and the right hand tab-switch should be set several spaces prior to the desired right hand margin. The automatic typing will generally stop two character positions after the right hand tab-switch. When starting in the JUSTIFY mode, data always must start at the beginning of a line (i.e., just after a carriage return). Number buttons and text segments buttons are not used in JUSTIFY.

Occasionally the machine may come to its premargin stop just before or just after a case-shift character. If there is doubt, as say when the machine puts an initial capital letter and stops, the operator may insert the shift, and no error will result, even if it is extra.

3.2.5 Text Segment Buttons

The machine will recognize the following six classes of natural text segments, which the operator may select by pushbutton. The selection of one will cancel a previous selection.

CHARACTER - Any non-blank tape code is considered as a character, including case shifts, non-escaping symbols, spaces, and carriage returns.

WORD - A word is any code sequence ending in a carriage return and preceded by a character not carriage return, or ending in a space and preceded by a character not space.

LINE - A line is any code sequence ending in a carriage return and preceded by a character not carriage return.

SENTENCE - A sentence is any code sequence ending in a sub-sequence period space space, or period carriage return, or period space carriage return.

PARAGRAPH - A paragraph is any code sequence ending in a tab.

RECORD - A record is any code sequence ending in a stop code.

3.2.6 Number Buttons 1 - 30

The number of text segments to be processed will be chosen by pushbuttons labelled:

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30

One and only one of these may be chosen, and the selection of any one will cancel previous ones. The operator will note that the 1 - 9 buttons remain depressed when selected, whereas the 10, 20, and 30 buttons are spring return buttons. Noting this, the operator should be sure that the 1 - 9 buttons are fully operated, and not merely tapped. If no number is selected, the device will process 32 text segments before stopping. If no text segment is selected, the device will process text indefinitely.

3.2.7 HIGH SPEED

This button affects the COPY mode only, as explained in Section 3.2.1, and causes copying to proceed at 50 characters per second rather than at keyboard speeds. DELETE always occurs at 50 characters per second, and JUSTIFY always proceeds at keyboard speed. The illumination of the right hand switch on the equipment cabinet (the one that turns on the punch and reader) will glow brighter when HIGH SPEED is on and will be somewhat dimmer when HIGH SPEED is off. The HIGH SPEED button turns this mode both on and off.

3.2.8 CLEAR

The CLEAR button is used initially to insure that the machine is empty of data before an operation is started. It resets all storage elements to their "zero" state and sets the machine in an "idle" state, awaiting an instruction.

During automatic operation, CLEAR will stop the machine abruptly. During keyboard entry, CLEAR may be used to delete the last two characters typed. When switching between editorial functions, it is advisable to CLEAR first.

3.2.9 PAUSE-RESUME

The PAUSE-RESUME button permits the operator to stop the machine in mid-operation and then resume operation without losing any of its stored data or counts. It is useful for many purposes and may be used as a "panic button" if the typewriter paper should suddenly jam, or some similar disturbance occur.

The two characters of stored data within the machine are processed prior to stopping during a PAUSE, so that if the segment count is not important, a new operation may be set up after a PAUSE providing a CLEAR is first initiated. Normally, the PAUSE-RESUME button will be depressed a second time to continue the operation that was suspended by the first press.

3.2.10 START

The START button performs two functions: It causes the machine to begin executing the set up instruction, and it also transfers the desired number from the console switches to the operation counter. Hence instructions may be repeated by

merely depressing the START button after each instruction has been completed. The START switch is especially useful as an indexing switch to process text segments incrementally rather than by counting. Used this way, an instruction such as "COPY 1 WORD" may be repeated by depressing the START switch until the desired location of text is reached. START should not normally be used after a PAUSE, since it will cause the present instruction to begin again rather than continuing the interrupted process.

4. CONSOLE DISPLAYS

4.1 MODE DISPLAY

Another indicator on the operator console displays, in words, the current mode of the machine, such as DELETE LINE, COPY WORD, etc. Since all mode controls are light force, fast acting pushbuttons, this feature serves to remind the operator of the last instruction called for.

4.2 BUFFER DISPLAY

The last stage of the buffer memory activates indicator lights on the operator's console and displays the code next in line to be punched. This is useful whenever an operator is in doubt as to whether a wrong key has been struck, and it also displays any incorrect code that may have engaged the parity circuits. Recalling that two characters of storage exist, the character corresponding to a particular keystroke will be displayed when the next keystroke is made and will be punched when the keystroke after that is made.

5. MASTER SWITCH PANEL

A master switch panel just inside the rear door of the equipment cabinet contains 77 miniature toggle switches for code selection and special functions. These are shown in Figure 4.

5.1 CODE SELECTION SWITCHES

The nine columns of eight switches each correspond to the tape codes for the nine principal delimiters that are recognized, and the markings indicate their identity:

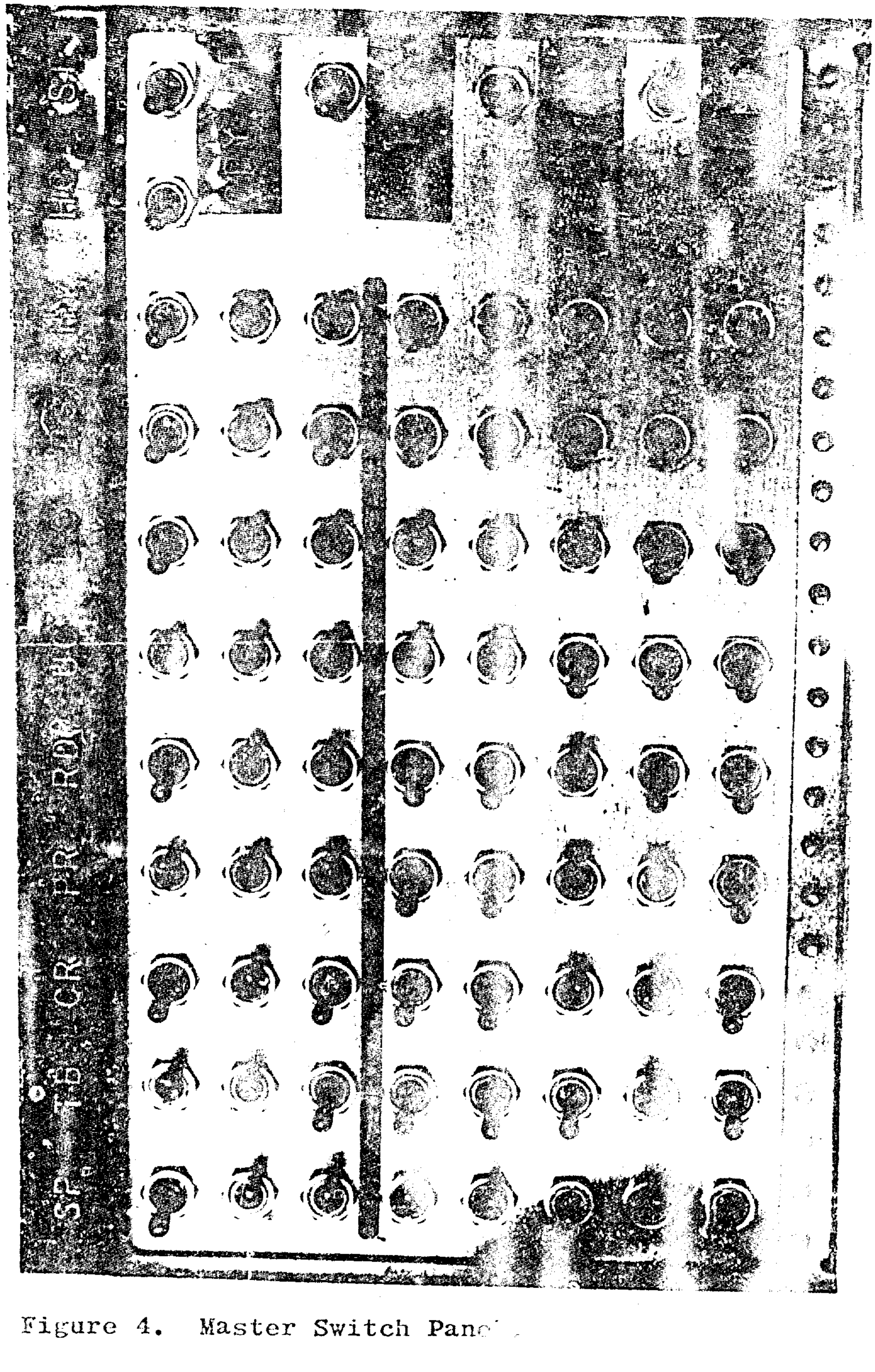

Figure 4. Master Switch Panel

SP = space
TB = tab
CR = carriage return
PR = period
RD = record
UC = upper case shift
LC = lower case shift
BS = backspace
HY = hyphen; HC = hyphen case

These code switches allow 5 to 8 channel tape-typewriter codes to be set up quickly. A left-pointing switch indicates "zero", a right-pointing switch indicates "one"; and tape code hole numbers progress from top to bottom using the conventional sequence 1, 2, 3, sprocket hole, 4, 5, 6, 7, 8. The hyphen case switch selects whether hyphens are to be detected as upper or lower case symbols. In normal operation, these code switches should never be touched once set for a particular tape code. The RECORD code, however, may be set to any code that is desired as a record-delimiter, such as stop-code. The code for space is also set on switches adjacent to the tape-typewriter input cable and should also be set to correspond to the tape code.

5.2 INTERNAL SPECIAL FUNCTION SWITCHES

Four switches on the right hand column (SF) of the inside switch panel may be used to activate special functions.

5.2.1 COPY BLANK Circuit

The TRED normally ignores blank tape, but at option, the operator may set an internal COPY BLANK switch (CPY BL), which will cause the machine to copy blank tape portions which are included in the text tapes.

5.2.2 DUMP FINAL DELIMITER Circuit

The TRED normally copies all terminating delimiters, but in some cases, it may be desired not to copy special terminating codes which may interfere with subsequent processing. When the internal DUMP FINAL DELIMITER switch (DEL FD) is activated, the last code, which normally would be punched for a given instruction, is deleted.

5.2.3. COPY-HYPHEN-JUSTIFY Circuit

TRED, in justifying, normally pauses in the internal part of a line if it encounters a hyphen. If this is not to be included in output, the operator presses the PAUSE-RESUME button, and the machine continues without punching the hyphen. If the hyphen is to be retained, a rarer case, the operator switches to the INSERT mode and enters it. If, for special use, all codes are to be retained and hyphens exist in the text, faster justification can be obtained by activating the COPY-HYPHEN-JUSTIFY switch (CPY H-J), in which case during justification all internal hyphens will be copied, and no pause will occur.

5.2.4 PARITY Check

When the machine is used with parity codes, a PARITY switch on the inside may be set to engage a parity detector, which will halt the machine if an incorrect code is encountered prior to punching it. Since the tape-typewriter presently attached has a parity code, this switch is normally left on. Should an incorrect code be read or occur within the machine, it will stop with this code displayed on the console lights. Operation may be resumed by clearing and restarting or by flicking the parity switch.

THE AUTOMATED EDITING OF TEXT VIA COMPUTER AND OFF-LINE DEVICES

By William R. Nugent
Inforonics, Inc.
Maynard, Massachusetts.

ABSTRACT: Automated aids to editing of textual matter in machinable form are described, and present on-line computer techniques are discussed. The need for small-scale, inexpensive editing devices is shown. The current development of one such device, EDITOR I, is described.

Summary

Automated aids to editing of textual matter in machinable form are described and the use of computers and special devices is compared. Current research and development has revealed five important points which are described in this report

1-The cost of data preparation in machine form frequently exceeds the cost of subsequent machine processing.

2-The most frequent bottleneck in data preparation is not the first keying, but the editing phase in which errors are removed and changes in substance and style are made.

3-Automated aids to editing can provide substantial savings in all forms of documentary data processing. This is due largely to the maximal preservation of correctly keyed data, which is often necessarily re-keyed in manual systems.

4-On-line computer editing techniques can be very economical when program flexibility is combined with rapid manmachine communications. On-line cathode ray tube displays appear to be the best present means of effecting this communication.

5-Off-line special devices can provide a high percentage of computer capability in editing for a low percentage of computer cost, due to the comparatively lower requirements of complexity and speed.

Introduction

The requirements of textual data processing have not yet been fully realized by many designers of computing machinery and peripheral devices who still apparently regard their machines as number processors of the traditional type. Whereas number processing uses low volume input and output, text processing requires large volumes of input and output data. This difference results in an economic balance unknown in number processing. Accurate textual input date in machine form is a valuable property. The cost of processing time is often small with respect to this. For example, a recent study of costs involved in the automated processing of library cards showed that the cost of data preparation for a typical master card (similar to a Library of Congress card) was about 26.6 cents. The cost of processing this entry to produce an average of eight other cards for crossfiling purposes was about 25.3 cents. Similar situations occur in text records as diverse as intelligence reports and inventory listings.

Problems In Manual Text Editing

In speaking of editing text, the primary concern is with the editing of machine input records on perforated tape. Documentary data does not lend itself readily to being quantized into 80-column segments; the variable nature of text is better and more usually accomodated by variable length records of perforated tape produced on a tape typewriter. It is the difficulty of editing text on tape typewriters that creates the need for additional automation.

At first consideration, the ordinary tape typewriter appears to have great possibilities for text editing, in that the machine record would seem ideally suited to avoid the several passes of human retyping that normally go into the preparation of final copy of various documents. The failure of the tape typewriter to meet these expectations has disappointed many business people who did not consider the differences between tabular material and text and the restricted controls on available machines. To date, the tape typewriter has been highly useful in creating and reproducing machinable records, but has not been too useful where the principal requirement is an edited page of text. Following is a description of the major problems that exist.

Distinction between Change of Content and Error Correction

A major point that is often overlooked in discussing machine aids to editing is that tabular editing largely requires only correction of typing errors, whereas text editing requires changes in content as well. Where content is changed for reasons of error or style, the effect of such change can be propagated through the remainder of the document. In simplest possible terms, the remainder of the document, though correct in content, is no longer correctly justified and, therefore, may not be copied as the remainder of the corrected tabular listing may be. It is on this rather obvious distinction that even some computer-controlled systems break down, and experience has shown that it is usually faster to manually retype text with justification problems than to try and modify it on a tape typewriter.

The Problem of Complexity

Complexity in editing on tape typewriters is not due to an excess of controls, but rather to the fact that these controls do not always work in a satisfactory way, and several controls must be coordinated to perform a simple conceptual action, such as deleting a word. Novices often find the controls for starting and stopping the reading of tape particularly frustrating since it is very difficult to advance accurately over a chosen segment of text and stop at a desired spot. There are several basic reasons for this: readers operate with a character time shorter than human response time; many machines have slow response controls; and some actions may be initiated or stopped only at certain portions of the character cycle with the result that there is often no exact time relation between the initiation of a control switch and the consequent action.

A further problem occurs in skipping portions of the input tape. With no page copy for a guide, the operator must manually advance the tape the required distance. Unlike old-time telegraphers, who could read perforated tape as well as print, tape typewriter operators must usually depend on an accurate count of clicks of the tape advance detent to reposition their tape in the reader. A mistake in this operation then requires that the tape in the punch be repositioned by hand with the added complication that a wrong move here can cause tearing if unpunched tape is advanced over the punchhead. In general, once any tape must be manually repositioned, the probability of additional error begins to avalanche. A further problem is the disjointedness of control in editing. The reader, punch, and typing mechanisms may each be in one of two states, resulting in seven possible wrong combinations for any given editorial task.

What is necessary for adequate editing of text on perforated tape is simplified integrated control in terms of the editorial action the operator wants to cause, rather than in terms of the particular mechanism used and its several parts. This approach has been followed in both on-line computer editing and special device development.

Editing By Computer

The first application of computers to editing was in the correction of computer programs. (1-5) Programmers quickly discovered that editing which would take an hour by usual tape typewriter methods could be done in minutes on the computer. The economics of such discoveries are rarely considered; when a machine on hand can eliminate an onerous human task and produce the finished job much faster, it is merely adopted. It has been determined that in the case of medium scale machines, the increase in programmer effectiveness easily pays for the few minutes of computer time used.

In the case of text editing on computers by a non-programmer, the operating situation changes somewhat, but the effectiveness and speed can be just as high if the editing programs and controls are designed with an editor in mind rather than a programmer. Programs for editing purposes tend to be too complicated for a report typist to run. Hence, the requirement is to make the computer operation be in editorial terms. A small cable-connected "editor's console" satisfies this requirement. Currently, experiments are being made with a variety of configurations; a typical one is a keyboard about the size of an adding machine on which there are 18 pushbuttons and switches, each corresponding to a particular editorial function such as "change word" and "insert line". A computer-connected typewriter may serve as the text display, though it has been found that a computer-connected cathode ray tube is preferable since it provides instant display of the page being operated on and allows a much greater flexibility. For making changes in style or content, it is particularly suitable since an editor may experiment with phraseology or layout, see how it "looks in print", and either make further changes or release it for output.

Editing With Special Devices

Because of the great facility with which editing may be done on computers, it is natural to consider applying these techniques to special devices designed especially for editing. A recent Time article (6) contained an imaginative sketch of an automated editor's desk of 1973, which combined multiple cathode-ray tube displays and computer control features into an editorial command center of impressive proportions. The technology is not lacking to build such devices, but the funds probably are.

A requirement for the present is for low-cost special devices which may serve the editing needs of organizations which could not justify the use of computers for the task. Rome Air Development Center has recognized such a requirement, and the author currently is developing such a device under an Air Force contract. This device, tentatively named EDITOR I, will provide much of the capability of computer editing technique at a fraction of the cost.

EDITOR I consists of a high-speed tape reader and tape punch, a small 'Editor's Console' similar to those we have connected to computers, and a moderate amount of internal logic. It works in conjunction with a conventional tape typewriter. All control, however, is from the "Editor's Console' in terms of natural editorial functions.

The device will be in operation this year, and computer simulation of the device now indicates that fast and simple editing is obtainable inexpensively by special purpose off-line devices.

REFERENCES

1. McCarthy, John, "Typewriter Control", (TYC BBN-2), January 1960 DECUS Program Library, Digital Equipment Corporation, Maynard, Massachusetts.

2. McCarthy, John and Silver, Roland, "Colossal Typewriter Program", December 19, 1960, BB&N Program Library, Bolt, Beranek, and Newman, Inc., Cambridge, Massachusetts.

3. Piner, Steve and Samson, Peter, "Expensive Typewriter", (MIT-2), February 7, 1962, DECUS Program Library, Digital Equipment Corporation, Maynard, Massachusetts.

4. Rousseau, Allen, "Frapcorrector", April 11, 1961, Adams Associates Program Library, C. W. Adams Associates, Inc., Bedford, Massachusetts.

5. Rousseau, Allen, "Typewriter Inquiry Control", (TIC), April, 11, 1961, Adams Associates Program Library, C. W. Adams Associates, Inc., Bedford, Massachusetts.

6. "The Press", Time Magagazine, July 5, 1963, p.52.

Work on computer-controlled cathode ray tube editing is being supported in part by U. S. Air Force Contract AF19(628)-10; development of an off-line editing device is being supported by U. S. Air Force Contract AF30(602)3088.

Part II: Logic and Circuitry

The functions and operation techniques of the Text Reporting and Editing Device are described in Part I of this report and serve as an introduction to Part II, in which we describe the details of the logic and circuitry which accomplish these functions. After discussing the general plan of the machine, we will discuss the schematics in turn.

1. GENERAL PLAN OF THE TRED

The TRED is designed to process text tapes with speed and economy and operates from keyboard instructions set up on a pushbutton console. Since an operator directs the processing in much the same manner as operating a keyboard calculator, in this context, "fast" is any speed which results in operation times which are small with respect to operator thinking and set up times. For the task considered, 50 characters per second serves this function and permits economy through the use of high speed relays as the principal logical elements. The relays used are data processing types, rather than telephone types, and have a life expectancy of several hundred million operations. Semiconductors are used for timing and driving circuits, and these are all-silicon and worst-case designed for long life under adverse conditions.

Synchronous logic is used throughout to insure predictable functioning independent of operation or propagation time. A two-cycle clock generates series of two 10 millisecond pulses for high speed operation and series of two 60 millisecond pulses for keyboard operation. All operations are slaved to the Teletype punch, which must be synchronously operated from its own timing, and are also slaved to the tape-typewriter. The clock pulses θ_1 and θ_2 run throughout the system, and in general, θ_1 is action time, and θ_2 is propagation and waiting time.

There are three modes of timing. In "non-keyboard" mode, synch pulses from the punch initiate a 10 ms θ_1 time pulse, and θ_2 time is from the end of θ_1 until the next synch pulse arrives. This results in a series of two 10 ms pulses for each character time or bit. In "keyboard operation" mode, a punch synch pulse initiates a 60 ms θ_1 pulse, and this is followed by a 60 ms θ_2 pulse terminated by the next synch pulse. In "keyboard entry" mode, the tape-typewriter initiates a θ_1 pulse of a nominal 60 ms period, which may not be terminated until a punch synch pulse has arrived, and shortly afterwards θ_2 begins. In all modes, reading and punching take place during θ_1 time.

All data flows through four successive stages of an 8 bit buffer, resulting in two data characters between input and output. At time 1, data is read and entered into stage 1 of the buffer; at time 2, decoded output is available; and at time 5, it will be punched or not depending on the state of the systems.

The machine contains 8 banks of relays for logic, a row of silicon semiconductor circuits on printed circuit boards for timing and driving, and four DC power supplies. Low level transistors use +10 v and -12 v; the punch solenoids use +28 v; and the relays use +46 v. In almost all cases, ground is switched and constitutes a "one". The tape-typewriter has an unfiltered 90 v power supply, which is also used for driving it from the TRED.

The general bank layout of machine logic is shown in Drawing L1. The 4 stage buffer decoder occupies Banks 1, 2, and most of 3. The Start-Stop controls, which control the running, punching, and punch-inhibiting, are contained in Banks 3 and 4. Most of Bank 4 is devoted to the justification circuits, which control the operations and character disposition during justification and contain the logic for substituting spaces for carriage returns, etc. Bank 5 has the console controls, which convert console pushbutton operations into machine instructions and provide function interlock and hold, decimal to binary decoding, and pulse generation. Bank 6 contains 2 binary counters; an operation counter, which records the number of text segments processed; and a bi-directional counter, which is used in justification. Bank 7 contains timing and mode switching circuits, as well as some justification circuits. Bank 8 is adjacent to the tape-typewriter input cables and is used to switch typewriter control to the TRED when TRED power is on and restore it to the tape-typewriter when TRED power is off.

2. LOGIC DESCRIPTION

In describing the logic of the TRED, we will follow the sequence of logic diagrams and explain these individually.

2.1 DECODER-BUFFER (Dwg. L2)

The Decoder-Buffer is an 8 bit, 4 stage shift register, whose first stage is driven by the reader or the typewriter via solid state relay drivers, and propagates successive characters through the four stages. Since all 8 bits are identical, only one bit is shown in detail. As in most of the machine, double coil relays are used having an operate coil and a high resistance hold coil.

These coils are connected to a common +46 v supply, and the unmarked input is the operate coil, and the input marked by the black semi-circle is the hold coil. Spark suppressors are used on all hold coils and on those operate coils marked with an "S".

Examining the circuit of Bit 1, relay 4 is driven by a relay driver sometime during the time 1 and locks up for the duration of $\emptyset_1$. Relays K1 and K2 operate at the same time, and the contacts of these relays decode the input character, which is available at time 2. At time 2, the data in K1, K2, and K4 is shifted to K3. At time 3, another character is read, and the bit that was in K3 shifts in to K33. At time 4, the bit in K33 shifts to K41. At time 5, the bit in K41 is available for output and will be punched if instructed. Separate contact lines are used for typewriter and punch output; typewriter 90 v is switched through the #2 contacts; and ground through the #3 contacts goes to the punch drivers. Contact 1 switches ground to the buffer lights on the console.

The third stage of the buffer contains the parity checking circuit so that the detection of an incorrect character may stop the punching of that and subsequent characters. Each relay of the buffer, excepting the first post-driver relays (K4, K5, K12, K13, etc.), operate for two clock times, transferring their data to the next stage at the second of the two clock times, and dropping out during the third clock time.

2.2 DECODER-ENCODER SWITCHING (Dwg. L3)

Seventy-three toggle switches work in conjunction with stage 1 of the buffer (relays K1; K2, K6; K7, K9; K10, K14, K15, K17; K18, K22; K23, K25; K26, K30; K31) to decode the 9 principal tape codes used for delimiters and to encode a "space" signal for insertion purposes. Codes of 5, 6, 7, or 8 bits may be set up, and the switches are set to the right to indicate "one". The top-most switches on the panel are for the 1-bit and progress downward using the tape convention: 1, 2, 3, sprocket, 4, 5, 6, 7, 8.

To read other than 8 bit codes, the codes should be set up using the sprocket location as a guide rather than any arbitrary numbering convention. Teletype 5 channel tape codes, for instance, would be set up on the first 5 switches, and these would correspond to an inverse numbering for Teletype tape, which is normally 5, 4, 3, sprocket, 2, 1. Channels 6, 7, and 8 would generally be disabled at the reader or the buffer input to avoid spurious readings from these channels.

2.3 START-STOP CONTROLS (Dwg. L4)

These relays control the starting, stopping, and delimiter decoding of the machine. Relays K73, K74, K75, and K76 decode the "sentence" signal, which is defined as period space space, period carriage return, or period space carriage return. All character signals occur at Q_2 time. "Period" operates K37 and allows K75 to be operated during the next Q_2 time if "space" is present. At the following Q_2 time, a "space" signal through K76 will result in a "sentence" output. Other "sentence" signals are derived similarly.

Relays K67 and K68 decode the sequence $\overline{CR}$ CR, which is the "line" delimiter, and relays K139 and K144 decode the $\overline{SP}$ SP signal, which along with $\overline{CR}$ CR is the "word" delimiter. This definition avoids operator confusion when variable numbers of non-printing CR's and SP's separate items, since it permits only printing segments to be counted.

Relays K48, K49, K50, and K51 constitute a delay line, the last stage of which inhibits punching. The diode inputs to this chain serve to shut off the punch. The BS input, for instance, disables the BS code by operating K49, which will cause K51 to be operated one character time later, and disables the previous code by operating K51.

Relays K77 and K127 delay the "character" signal CH at time 2, creating CH1 at time 3, and CH2 at time 4. A character is any non-blank code.

Relay 47 is one-half of the "reader stop flip flop"; the other half is K109 of the operation counter. When this flip flop is on, it propagates a stop signal down to the "punch-off" delay chain. Timing is arranged so that the reader shuts off and turns on 2 character times before the punch to allow for the 2 characters of storage.

Relays K44, K45, and K46 constitute a "one-shot" circuit which delivers one ϕ_2 reset pulse to the operation counter upon being initiated by console pushbutton. This pulse causes a chain of events which resets the counter, loads a new number into it, and turns off the reader stop flip flop, causing a new operation to be started.

The "pause-resume" circuit is similar. Relays K41, K42, and K43 generate a single ϕ_1 pulse (PRFF), which sets or resets the pause-resume flip flop (K70, K71, K72). Pause-resume does not affect the operation counter, however, so that orderly interruption and resumption are possible. No data remains in the buffer after a "pause-resume" stop.

2.4 JUSTIFICATION CIRCUITS (Dwg. L5)

The justification circuits serve to rearrange the format of text which is otherwise correct. The JUSTIFY mode operates the tape typewriter and must begin at the beginning of a line. Keyboard switch 1 is set at the left hand margin, and operates K52 when a new line begins. This is essentially a "priming" operation which sets up the machine to receive the signal of keyboard switch 2, which indicates that justification range has been reached. With K52 on, the text is copied, and whenever a carriage return is detected, it operates the "stuffer" circuit (K64, K65, K66) which inhibits mid-line carriage returns and stuffs in spaces in their place. A period preceding a mid-line CR will operate K62, which causes two spaces to be substituted for the carriage return (sentence ending). If a hyphen preceded the mid-line carriage return, it will be inhibited, and the pause-resume flip flop will be activated for a "hyphen pause". If no hyphen is required, the operator activates the pause-resume button, which continues automatic operation.

When the right hand margin reed switch is activated, it indicates that justification range has been reached, and the machine switches to a "range" mode. K53 operates, releasing K52, and turns on the pause-resume flip flop via a PRFF signal. It also switches the clock controls from a "keyboard operation" mode to an "insert" mode.

At this time the buffer will be empty, and perhaps a portion of a word will have been typed. The operator must now supply the line-end information. If the keyboard had printed "in" of the word "information", the operator could type either:

(a) -
(b) for-
(c) formation

In each of the above cases, the machine would count the number of data characters entered via the bi-directional counter (0 in case a, 3 in case b, and 9 in case c). The carriage return ( ) serves as the line-end signal and switches the justification circuits to a "skip" mode, and switches the clock controls back to "keyboard operation" mode.

The "skip" mode is initiated by a CR operating K56, which releases K54 and other "range" relays, and causes data to be read again. The bi-directional counter now "counts down" on data characters, and no punching occurs until this counter reads zero. K60 operates then, and via K59 shuts off the "skip" relays, and the machine returns to copying data.

Relay K78 gates various signals with JUSTIFY, and relay K69 removes a count from the bi-directional counter (if it contains a number) when a BS is detected.

Relays K145 and K146 are used to hold the hyphen signal when it is followed by a lower case shift, so that the hyphen-CR sequence may still be detected.

Relays K124, K125, and K126 constitute a "case" flip flop, which holds the case of data so that hyphens may be detected in one particular case, as set by the panel HC switch.

The delay stages of the "range" and "skip" signals are used for timing on-off and count operations.

2.5 CONSOLE CONTROLS (Dwg. L6)

The console control relays hold the console push-button signals and convert them to proper form. The editorial function relays (K79, K80, K81, K82) form an interlocking set

such that only one may be operated. The same is true of the text segment relays K83, K84, K85, K90, K91, and K92. The 10, 20, 30 buttons are also connected to three interlocking relays, K94, K95, and K96. These generate a binary input to the operation counter. The decimal switch assembly has a binary output which is used similarly, and this is interlocked with the 10, 20, 30 relays by means of a reset solenoid, which is activated by any of the 10, 20, 30 buttons. A "clear" relay, K89, removes Q_2 from all banks when operated, and also turns Q_2 on. A delay relay, K93, serves to hold Q_2 on the reader stop flip flop during "clear" time.

The HIGH SPEED button operates the "high speed flip flop" K86, K87, and K88, and also turns it off.

2.6 BI-DIRECTIONAL COUNTER (Dwg. L7)

This is a 4 bit bi-directional counter that is used during line-end operations in the JUSTIFY mode. It counts up the data characters entered manually at line-end and counts down an equal number of characters to "skip" after a carriage return has been entered.

Relays K99, K102, K105, and K112 hold the count; the relays K98, K101, K104, K111, and K114 are used for counting up, and the others are used for counting down. The number of keyboard characters entered must be 15 or less, lest overflow occur. During count down, underflow is prohibited, and the counter will not cycle upon reaching zero. The counter does not accept carriage returns, spaces, hyphens, or case shifts as counting characters. Upper case shifts, however, may terminate the "skip" mode when the count equals zero.

2.7 OPERATION COUNTER (Dwg. L8)

The operation counter is loaded with the console-selected number when START is activated, and then counts down on the selected text segments. It is a 5 bit counter, and relays K107, K116, K118, K120, and K122 hold the count. When the count is 1 and a count is received, a "last count" signal is generated which terminates the operation. Underflow is not prohibited since it never occurs under normal operation; if, however, no number is selected on the console, the counter will cycle from 0 to 31 and continue to count selected text segments until a "last count" signal occurs,

so that 32 segments will be processed before stopping. Relay K109 constitutes half of the reader stop flip flop and is released when K109 operates. K109 also sends a probe through the binary switches and loads the counter through its contacts 1-5. K108 operates when a reset pulse is generated, and breaks the ϕ_1 holding path to the counter one bit time prior to loading.

2.8 CLOCK CONTROLS (Dwg. L9)

The clock controls operate in conjunction with the console control relays (Dwg. L6) and the timing modules (Dwg. L14) to provide clock ϕ_1 and ϕ_2 pulses properly synchronized to the particular operation. From a timing point of view, there are three machine modes: non-keyboard, keyboard operation, and keyboard entry. The non-keyboard mode occurs during DELETE or COPY HIGH SPEED. K152 operates in this case and controls the generation of successive 10 ms pulses synchronized to the punch. The keyboard operation mode occurs during COPY with HIGH SPEED off and during most of JUSTIFY. Relays K140 and K141 are operated in this case and control the generation of successive 60 ms pulses synchronized to both punch and keyboard. In the keyboard entry mode, timing is slaved to keystroke operation and relays K142 and K143 are operated.

In non-keyboard operation, with ϕ_2 on, a punch synch pulse, after shaping, is fed through the idle tape-typewriter contacts and appears back on 1C of K128. K152 is operated so that the synch pulse appears on 2C of K150, and from 2N of K150 it is sent to a 4 ms multivibrator, which drives a synch driver to operate K147. K147 and K128 generate a 4.5 ms ground pulse to probe the reader and operate the punch, and simultaneously cause ϕ_1 to come on via 3C of K147. K148 then operates and removes the "ϕ_1 fire" signal for the duration of ϕ_1, and starts the 10 ms timing module T2 via contact 5C. When T2 fires, K130 operates and fires ϕ_2, turning off ϕ_1. The next punch synch pulse will arrive 10 ms later to turn on ϕ_1 again.

In the keyboard operation mode, with ϕ_2 on, a punch synch pulse is fed through tape-typewriter carriage motion contacts, and if these are at rest, delivers a pulse to K128-1C as before. This pulse is fed through K133-3C, K133-3N, K140-1C, K140-1T, K150-2C, and K150-2N to drive the multivibrator and cause the operation of K147, K128, and K148 as before. K148-5C starts timing module T4 timing

for 60 ms, which is the ϕ_1 duration, and starts T3 timing for 22 ms. K133 causes K157 to operate through a back contact of K131, and this drives the mercury-wetted contact relay K157 to switch tape-typewriter 90 v through the buffer probe line (P GO F) to the tape-typewriter translator. When T3 has timed 22 ms, K131 operates and breaks the K157 operate path. When T4 has timed 60 ms, K132 operates and fires ϕ_2. T5 starts at this time and operates K134 at the end of 60 ms, which breaks the holding path for K133, thereby restoring the synch line to a non-busy condition via K133-2N, permitting the next synch pulse to fire ϕ_1. Timing modules are adjusted to give symmetrical ϕ_1 and ϕ_2 pulses during non-keyboard and keyboard operation modes of 10ms and 60 ms respectively.

During keyboard entry, with ϕ_2 on, a cycle is initiated by a keystroke, which delivers a keyboard selector pulse (SCC+) to operate K149, which in turn causes ϕ_1 to fire via K149-3C. K135 then operates via K142-4T and generates an SCC-GO pulse for the duration of ϕ_1. SCC-GO probes the selector contacts to deliver a character code to the buffer relay drivers. ϕ_1 timing is prohibited from starting until a synch pulse has been passed and K147 and K148 have been operated. This insures that no long-time character, such as CR, will be missed because of extended open-time of the carriage motion contacts. When K148 operates, T4 commences timing and 60 ms later ϕ_2 fires via K132.

During Justification, the machine is required to switch timing modes while processing. K151 switches from keyboard operation to keyboard entry when the "range" position has been reached, and the last character in the buffer has been processed. K150 turns the keyboard operation mode back on when the line-end CR is deleted. K150 is made slow-releasing to delay synch restoration until transients resulting from the switch have passed.

2.9 FLEXOWRITER SWITCHING (Dwg. L10)

When the machine is off, all Flexowriter connections are restored to normal via relays K153, K154, K155, and K156. When the machine is operated, the 46 volt supply operates these relays and causes Flexowriter control to be switched to the TRED, and causes the Flexowriter reader and punch to be disabled. Punch synch is fed through the Flexowriter's carriage motion contacts, and the SCC-GO probe is

fed through the selector contacts during keyboard entry. The translator magnets are driven by the Flexowriter power supply switched through the TRED.

2.10 READER-PUNCH-POWER WIRING (Dwg. L11)

Power is turned on by the two cabinet switches which apply AC to the power supplies and motors. Most fusing is on the rear power panel, except for the reader and the 28 v supply, which have internal fuses. The 28 v supply is accessible by removing the front panel beneath the punch; other supplies are accessible via the side doors. Numbers and letters adjoining the small circles in the reader and punch diagram indicate internal connector designations; the numbers at the output lines indicate normal channel numbers; and the parenthetical designations indicate the terminals of the silicon drivers on printed circuit boards.

2.11 46 VOLT SUPPLY, CLOCK DRIVER (Dwg. L12)

The 46 volt supply is a full wave bridge using silicon controlled rectifiers as output and is regulated by a unijunction pulser. The regulator is on a printed circuit board and delivers firing pulses to the SCR's. A 6.3 VAC supply is included for powering the console mode indicator, and a small isolation transformer provides regulator power.

The clock driver consists of two pairs of SCR's connected so as to be mutually exclusive in operation. The capacitor serves to shut one side off when the other side is fired. The indicator lights show which side is fired, and these are on the back panel. If both sides are ever turned on at the same time, it is necessary to shut off power momentarily to restore operation. The CLEAR button causes Q_2 to fire, which is a required initializing operation after turning power on.

2.12 SILICON DRIVER MODULES (Dwg. L13)

The relay drviers and punch drivers are mounted on printed circuit boards having three drivers to a board. The parenthetical letters indicate the board connectors. The circuits use silicon semiconductors, metal film resistors, and heat sinks on output stages to provide reliability under adverse ambient conditions and age.

2.13 SILICON TIMING MODULES (Dwg. L14)

The punch synch pulse is first applied to a pulse shaper which is normally saturated. The negative portion of the synch pulse cuts off the shaper for about 650 ms. Thus the shaper is in its low-impedance state during off-time to minimize noise pickup.

Since the shaped synch pulse has to travel to the Flexowriter, through the carriage motion contact, and back to the P.C. boards, quite a bit of Flexowriter noise is picked up despite low-impedance circuitry. To avoid false triggering, the 4 ms multivibrator is preceded by a tuned filter maximally sensitive to the synch fundamental, and falling off in response at 12 db/octave outside.

The four timing modules use silicon controlled rectifiers to fire relays after a predetermined delay. Their inputs, at the 4.7K resistors, are normally at ground, and timing begins when the appropriate clock is delivering ground, and the input is switched to +46 v. The capacitor charges through the two resistors, and when it is a volt or so greater than the Zener breakdown voltage, the SCR fires, operating the connected relay.